Annual Report of the Board of Directors For the Period April 1, 1979 to March 31, 1980

CANADIAN ENERGY RESEARCH INSTITUTE

Annual Report of the Board of Directors
For the Period
April 1, 1979 to March 31, 1980

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OBJECTIVES OF THE INSTITUTE

Established March 24, 1975, the Canadian Energy Research Institute is a co-operative research organization sponsored by four parties. These are: the Alberta Department of Energy and Natural Resources, the Canada Department of Energy, Mines, and Resources, The University of Calgary, and the Private Energy Research Association--which is composed of corporate and individual members from oil, gas, coal, electrical, nuclear energy and pipeline companies.

In December 1979 the Institute moved from temporary quarters in the Library Tower of The University of Calgary to facilities in the new Energy Resources Research Building erected near the university campus by the Alberta Government. Other occupants of the new building are the Petroleum Recovery Institute, the Computer Modelling Group, and the Alberta Research Council. The building will also house the I. N. McKinnon Memorial Library which will contain energy-related books, journals and documents for the use of the research groups mentioned, and other interested parties. The new facilities, which include a board room and a lounge area, provide Canadian Energy Research Institute staff with excellent working conditions. Sufficient space has been allocated to the Institute to accommodate expected growth in Institute activities.

As set out in the Agreement among its sponsoring parties, the objective of the Institute is ". . . to develop an economic research capability which is recognized and respected in all matters related to energy, be it generated from petroleum and natural gas, coal, nuclear reactors, hydroelectric generators or any other source." To this end, the Institute undertakes and commissions studies and research analyses in the field of energy economics and energy policy to assist industry and government in dealing with energy problems. Through its publication program such efforts also aid public understanding of energy policy matters.

ADMINISTRATION AND STAFF

The Institute is directed by a Board of Directors through an Executive Director supported by a small secretariat. It meets quarterly. Each of the four sponsoring parties names three members to serve on the Board for three-year terms.

The Executive Director, J. A. Dawson, is also a Board member. During the fiscal year ended March 31, 1980, the other members of the Board of Directors were as follows:

University of Calgary:

F. A. Campbell, Professor, Department of Geology and Geophysics, The University of Calgary, Vice-Chairman.

D. J. Cote, Senior Vice-President, UMA Group Ltd., Calgary.

M. M. Williams, President, Calgary Power Ltd., Calgary.

Government of Alberta:

W. D. Dickie, formerly Alberta Minister of Mines and Minerals, Calgary.

M. F. Kanik, Assistant Deputy Minister, Policy Analysis and Planning, Alberta Department of Energy and Natural Resources, Edmonton.

T. L. Sindlinger, Alberta M.L.A. for Calgary-Buffalo, Calgary, (appointed to the Board July 1, 1979 to replace C. D. Guthrie, President, Guthrie McLaren Drilling Ltd., Edmonton).

Government of Canada:

A. D. Hunt, Assistant Deputy Minister, International Energy, Department of Energy, Mines, and Resources, Ottawa.

A. S. Rubinoff, Assistant Deputy Minister, Economic Programs and Government Finance Branch, Department of Finance, Ottawa.

O. J. C. Runnalls, Senior Adviser, Uranium and Nuclear Energy, Department of Energy, Mines, and Resources, Ottawa. (resigned June 15, 1979).

Private Energy Research Association

E. M. Lakusta, Senior Vice-President, Gulf Canada Resources Inc., Calgary.

R. W. MacPhail, Senior Vice-President, Kaiser Resources Ltd., Vancouver

A. H. Ross, Oil Consultant, Calgary, Chairman.

In addition to an Executive Director, the Institute's staff at year end comprised an Assistant Director, five economists, four research assistants, an administrative officer, a publications officer, and three secretaries. Another economist is to be added to the staff during the coming year. While there are no joint appointments with The University of Calgary, considerable interchange takes place with the University's Department of Economics as well as with research personnel on campus and elsewhere working on similar issues.

RESEARCH

Under the terms of the Agreement signed by the sponsoring parties, all research projects undertaken by the Canadian Energy Research Institute must conform with the Institute's objectives and must be approved by the Board of Directors. Subject to those limitations, a sponsor may specify the research that is to be financed by its payments to the Institute. If a sponsoring party wishes to provide funds in addition to those specified in the Institute Agreement, or if a party which is not a sponsor wishes to provide funds, the Board of Directors may approve the undertaking of research projects funded solely by such payments.

The year 1979-80 was a very active one for the Institute as seven new studies and four working papers were published. A brief description of each of the studies follows:

No. 3 The Effects of Rising Energy Costs on Canadian Industries. Anthony P. Ellison (former staff economist), April 1979. 62 pages.

"This study set out to ascertain those industries which are likely to be most affected by energy price increases and to estimate the total price impacts of such price increases on the economy as a whole." Using Statistics Canada's 1971 price Input-Output model it was found that the **industries that would experience noticeable price increases would be the hydrocarbon refining, transportation, pulp and paper, aluminum smelting and food processing industries.** Manufacturers of industrial chemicals, cement, and iron and steel would also see significant increases in production costs.

In one simulation the prices of all energy commodities were assumed to double at once. In other instances, the impacts of higher prices of individual energy commodities were examined. The all energy price 'doubling' simulation led to the greatest increase in the Consumer Price Index (4.8 percent). Within the CPI subgroups, the greatest impact was on transportation, housing, and food costs.

No. 4 Potential Markets for Thermal Coal in Canada, 1978-2000: Summary and Conclusions. Canadian Resourcecon Limited, June 1979. 27 pages.

This study is an assessment of the potential Canadian demand for thermal coal to the year 2000. The in-depth analysis upon which it is based is available as Institute Working Paper 79-2. The demand forecasts are based on explicit assumptions concerning prices of competing natural gas and fuel oil in Canada's various regions and on discount factors to reflect the additional capital and operating costs associated with the use of coal. It is indicated that **the potential demand for thermal quality coals in Canada could be of the order of 100 million tons annually by 2000.**

Total thermal electric coal demand in Canada is forecast to increase from 25 million tons in 1977 to 70 million to 90 million tons annually by 2000, with most of the consumption in Alberta, Saskatchewan and Ontario. In addition, industrial coal demand in Canada is projected at about 24 million tons, not including metallurgical coal used by the steel industry.

No. 5 Energy in Canada: Review and Outlook to 1995. W. Brent Friedenberg (staff economist), July 1979. 140 pages.

This provides an overview of Canada's energy supply and demand situation with an analysis of likely changes over the next fifteen years. The author indicated that **total energy consumption would be likely to grow at an average annual rate of about 3.1 percent to 1995** on the basis of analysis of energy consumption by fuel type and region. **Indicated growth rates for individual energy sources to 1995 were 5.1 percent for coal, 4.8 percent for hydro and nuclear, 1.1 percent for petroleum products, and 3.1 percent for natural gas.**

Regional energy topics of interest discussed in the study include the extension of natural gas availability to the Atlantic Provinces and to eastern Quebec, the heavy reliance on nuclear power in Ontario's electricity generating expansion plans and, in every region, a very probable decline in the petroleum product share of total energy

consumption because of the assumed increase in the domestic price of crude oil. Projected annual rates of increase in total energy consumption to 1995 are as follows: Atlantic Provinces, 2.4 percent; Quebec, 3.3 percent; Ontario, 2.6 percent; Manitoba, 2.4 percent; Saskatchewan, 2.4 percent; Alberta, 4.2 percent; and British Columbia, Yukon and Northwest Territories, 3.8 percent.

No. 6 Energy Policy and the Balance of Payments: An Outline of the Issues. T. L. Powrie (consultant), July 1979. 61 pages.

Is the large deficit in trade of goods and services with foreign countries reason to export more natural gas, especially the specified surplus? This study addresses that question. Powrie's conclusion, when all has been taken into account, is that balance-of-payments effects are both transient and of low priority in decisions about energy policy. The author points out that ". . . any given change in exports or imports will of course have its direct impact on the balance of trade. But it will also have ever-widening rounds of indirect effects on international payments through feedback from effects on employment, investment, the exchange rate, perhaps the money supply, and so on." He also notes that ". . . additional exports of natural gas would obviously improve Canada's trade balance immediately. However, . . . additional gas exports, by strengthening the Canadian dollar in foreign exchange markets, may weaken the position of Canadian manufacturing against world competition. . . . Decisions about gas export permits should be based on appraisal of these broader effects on the Canadian economy."

No. 7 Oil and Gas Finding Costs. Russell S. Uhler (consultant), September 1979. 75 pages.

Uhler points out that costs associated with finding new crude oil and natural gas reserves cannot be forecast easily because of the crucial importance of plays in determining discoveries and the difficulty of precisely anticipating plays. However, once there is a

new play its occurrence can be built into the structure of a model of the exploration process and the implications for finding costs examined. Taking this approach, Uhler built models of the oil and gas discovery processes in order to examine developments in historical costs and to improve the ability to project finding costs. Two basic oil discovery models and one gas discovery model were specified and estimated.

Both oil models ". . . show substantially rising oil finding costs in recent years but tend to underestimate observed levels. These finding costs are also compared with wellhead prices and it is found that the price-to-finding-cost ratio has fluctuated in response to major new plays but has generally declined over time." Gas finding costs estimated with the gas discovery model indicate that ". . . the price-to-finding-cost ratio for gas exploration is now better than for oil."

No. 8 Energy Use in Canada in Comparison With Other Countries. Z. Charles Slagorsky (staff economist), October 1979. 91 pages.

Inter-country comparisons of the use of energy relative to output in various sectors of the economy can be useful for assessing a country's energy conservation potential. This is the approach taken by Slagorsky in this study in which he examines energy consumption per unit of output in the iron and steel and petrochemical industries, and in the transport, agriculture, and residential sectors for Canada and other major industrialized countries which belong to the Organization for Economic Cooperation and Development.

In comparison with Canada, energy consumption per dollar of Gross Domestic Product has been about 15 percent lower in the United States, the United Kingdom and the Netherlands, about 25 percent lower in Sweden and Japan, more than 30 percent lower in Italy and West Germany, and more than 40 percent lower in France. For all industries in total, some countries, such as West Germany and France,

were found to have significantly lower ratios of energy to output than Canada.

In the transport sector, it is indicated that Canada and the United States consume energy relative to distance travelled at approximately twice the rate of Japan and the West European countries. Given this and the fact that transport accounts for nearly 30 percent of overall energy use in Canada, a substantial potential for energy saving lies in the transport sector. An energy saving potential was also found to exist in the residential sector.

No. 9 Enhanced Oil Recovery Potential in Canada. J. Philip Prince (former staff economist), March 1980. 332 pages.

In this study the author examines the potential for crude oil production in addition to that forthcoming from primary and secondary (i.e., waterflood) processes. The enhanced oil recovery potential estimate was obtained with specific assumptions regarding changes in the price of oil, development costs, geological recovery factors, and pattern size. Three types of enhanced recovery processes were examined: thermal (steam drive, steam stimulation and in situ combustion); chemical (alkaline, polymer and microemulsion flooding); and miscible (carbon dioxide and hydrocarbon flooding).

Under assumptions of $20 per barrel for oil at the wellhead, an 8 percent real return on investment, and the present rules governing tax and royalty collection, the study indicates that a potential of 2.4 billion barrels of oil could be added to oil supplies as a result of the application of enhanced recovery techniques to existing oil reservoirs in Alberta. Extrapolation to Canada as a whole suggests a potential of some 4 billion barrels of oil, with most of the increase over Alberta attributable to the Saskatchewan heavy oil deposits.

The timing of development of Alberta's enhanced oil recovery potential is also examined. Given the assumptions made by the author, the potential would be produced over a 28 year period--with an average of 86 million barrels per year in the $20 per barrel case. However,

production would begin slowly, build to a maximum of about 240 million barrels annually around 1992, and then taper off gradually during the first ten years of the coming century.

The working papers released during the period April 1, 1979 to March 31, 1980 were:

79-1 An Input-Output Analysis of the Effects of Rising Energy Costs on Canadian Industries. Anthony P. Ellison (former staff economist), April 1979. 246 pages.

This paper contains detailed analysis and information related to the work reported in Study No. 3, which was published concurrently.

79-2 Potential Markets for Thermal Coal in Canada 1978-2000. Canadian Resourcecon Limited, June 1979. 321 pages.

This report contains background material and other analysis and information upon which the conclusions and summary presented in Study No. 4 are based.

79-3 Inter-City Comparisons of Canadian Household Energy Costs. Darcy-Gail Ackerman (former staff member), June 1979. 77 pages.

80-1 Government Incentives in Canada's Petroleum Industry. W. B. Friedenberg, Z. C. Slagorsky and A. J. Walsh (staff members), March 1980, 43 pages.

OTHER ACTIVITIES

In addition to the publication of studies and working papers, Canadian Energy Research Institute economists actively participated in many other economic activities during the year as summarized below. It is a policy of the Institute that its professional staff contribute to economic thought in Canada.

The Institute's Executive Director, Dr. J. A. Dawson, took part in a panel discussing energy topics at the annual meeting of the Canadian Institute of Mining and Metallurgy in Montreal, in April 1979.

- In May, he spoke at a conference examining "The Role of Energy in the Future Development of the Prairies," sponsored by The University of Calgary and the Calgary Branch of the Economics Society of Alberta.
- Later that month, he gave a presentation on the future of energy supplies in Canada at Informetrica Limited's semi-annual forecast meeting.
- In June, Dr. Dawson participated in a Toronto seminar sponsored by the Canadian Institute for Economic Policy dealing with "Strategies for the Current Account."
- More recently, in March 1980, he was a speaker at a Montreal conference on "The Economic Outlook for the 1980s," sponsored jointly by the Montreal Economics Association and the Montreal Chapter of the North American Society of Corporate Planners.

The Institute's Assistant Director, Dr. G. E. Angevine, was a speaker at Informetrica Limited's October forecast meeting in Ottawa. Following the Informetrica sessions he met with a number of economists at Energy, Mines and Resources Canada.

J. P. Prince (former staff economist) presented a paper on the "Alberta Potential for Tertiary Recovery" at the Technical Meeting of the Petroleum Society of CIM held in Banff in May.

Z. C. Slagorsky (staff economist) gave a paper on "Energy Use and Conservation in Canada in Comparison with Other Countries," at the same meeting.

· Slagorsky also gave a presentation comparing energy use in Canada with that in other countries at a monthly meeting of the Alberta Society of Engineering Technologists in Calgary in February.

In May 1979, G. J. Protti (staff economist) presented a paper with R. N. McRae (The University of Calgary, Department of Economics) on "The Impact of Rate Structure Change on Electric Utility Expenditures" at the annual meeting of the Canadian Economics Association in Saskatoon.

· In October, Protti was a participant on a panel focusing on the future use of fossil fuels in Canadian electricity generation at a Calgary meeting sponsored by the thermal and nuclear division of the Canadian Electricial Association.

· More recently, in March 1980, he talked to a meeting of the Power System Planning and Operations Section of the Canadian Electrical Association in Montreal on "Social Discount Rates for Project Evaluation."

W. B. Friedenberg (staff economist) attended the Fourth International Symposium on Petroleum Economics held at Laval University in Quebec City in October.

· Friedenberg and the Institute's Assistant Director attended the Fifth Canadian National Energy Forum held in Calgary in November.

In cooperation with the Calgary Chamber of Commerce, the Canadian Energy Research Institute sponsored a Markets for Canadian Uranium seminar in Calgary in October. With a roster of speakers organized by Professor John Runnalls of the University of Toronto (former member of the Institute's Board of Directors), the seminar was highly successful. The objective of bringing together information on a

number of questions concerning potential markets for Canadian uranium was achieved and the meeting was well attended.

The proceedings of the uranium seminar, entitled **Markets for Canadian Uranium**, were published in March 1980, and sent to those who registered at the conference. Additional copies are available upon request.

PROJECTS UNDERWAY AT THE END OF THE FISCAL YEAR 1979 - 80

At the end of the Institute's fiscal year, a number of projects were underway at the Institute. These included the following:

- A study by G. J. Protti (staff economist) and R. N. McRae (consultant) on The Impact of Rate Structure Change on Electricity Demand: A Case Study of Calgary Power Ltd. This study had been reviewed by outside reviewers and was about to be published as Study No. 10.

- A study on The Impact of a Sharp Oil Price Increase by G. E. Angevine (Assistant Director). This report had been read by two outside reviewers and was being readied for publication as Study No. 11.

- A draft of a proposed working paper on Electricity Supply Modelling by K. Foat and G. J. Protti (staff economists) was nearing completion.

- A collection of papers relating to the benefits and costs of oil self-sufficiency was being edited by J. A. Dawson (Executive Director). Core papers dealing with Prospects for Reduced Oil Consumption in Canada 1980-2000 (Friedenberg and Nixon); Government Incentives in Canada's Petroleum Industry (Friedenberg, Slagorsky and Walsh) and Alternative Future Supplies of Oil in Canada and Their Costs (Slagorsky) were in various stages of completion as working papers.

CONTRACT RESEARCH

At the January 25, 1980 meeting of the Board of Directors, a committee was established to develop a strategy to allow the Institute to seek financial support in addition to that being provided by its founding sponsors. One way in which this is to be achieved is through specific fee-based research assignments dealing with energy-related matters. The Institute's staff of professional economists have developed considerable expertise with respect to economic analysis pertaining to Canada's energy resources. They are well-equipped to assist government, industry associations and private companies in investigating matters involving energy economics.

The Canadian Energy Research Institute submitted a detailed proposal to undertake specified research for an energy industry association. Additional opportunities are being sought. Enquiries should be addressed to the Executive Director.

INSTITUTE FUNDING AND FINANCES

The second five-year Institute Agreement, covering the period to March 31, 1985, provides for annual grants to the Institute as indicated below. The annual contributions of the Alberta Government and of the Private Energy Research Association have been doubled from former levels of $125,000 and $100,000 respectively. Payments by the Government of Canada continue at $125,000 per year as in the original Agreement.

Alberta Department of Energy and Natural Resources.....$250,000
Canada Department of Energy, Mines and Resources.....$125,000
Private Energy Research Association.....$200,000

The University of Calgary provides the Institute with access to its research facilities on the same basis as that afforded a department of the University. It also serves as trustee and accountant with respect to the Institute's financial receipts and disbursements.

During the fiscal year the remaining contributions from the three funding organizations under the first five-year Agreement were deposited in the University Trust Account. Total expenditures during the year amounted to $525,077 in comparison with $366,930 in 1978-79; $295,574 in 1977-78; and $44,629 in the two-year period 1975-77.

PUBLICATIONS

Studies

No. 1 The Availability of Capital to Fund the Development of Canadian Energy Supplies. J.R. Downs. November 1977 (Price $3.00, 109 pages) ISBN 0-920522-00-9.

No. 2 The Industrial Demand for Oil and Gas in Ontario. DataMetrics Limited. March 1978 (Price $3.00, 119 pages) ISBN 0-920522-01-7.

No. 3 The Effects of Rising Energy Costs on Canadian Industry. Anthony P. Ellison. April 1979 (Price $3.00, 62 pages) ISBN 0-920522-02-5.

No. 4 Potential Markets for Thermal Coal in Canada, 1978-2000: Summary and Conclusions. Canadian Resourcecon Limited. June 1979 (Price $3.00, 27 pages) ISBN 0-920522-03-3.

No. 5 Energy in Canada: Review and Outlook to 1995. W. Brent Friedenberg. July 1979 (Price $3.00, 140 pages) ISBN 0-920522-04-1.

No. 6 Energy Policy and the Balance of Payments: An Outline of the Issues. T.L. Powrie. July 1979 (Price $3.00, 61 pages) ISBN 0-920522-05-X.

No. 7 Oil and Gas Finding Costs. Russell S. Uhler. September 1979 (Price $3.00, 75 pages) ISBN 920522-06-8.

No. 8 Energy Use in Canada in Comparison With Other Countries. Z. Charles Slagorsky. October 1979 (Price $3.00, 91 pages) ISBN 0-920522-07-6.

No. 9 Enhanced Oil Recovery Potential in Canada. J. Philip Prince. March 1980 (Price $10.00, 332 pages) ISBN 0-920522-09-2.

Conclusions and Policy Implications from Enhanced Oil Recovery Potential in Canada, Study No. 9. J. Philip Prince. March 1980 (Price $3.00, 32 pages) ISBN 0-920522-10-6.

No. 10 The Impact of Rate Structure Change on Electricity Demand: A Case Study of Calgary Power Limited. Gerard J. Protti and Robert N. McRae. April 1980 (Price $10.00, 182 pages) ISBN 0-920522-11-4.

Overview and Summary from The Impact of Rate Structure Change on Electricity Demand: A Case Study of Calgary Power Limited. Gerard J. Protti and Robert N. McRae. April 1980 (Price $3.00, 14 pages) ISBN 0-920522-12-2.

No. 11 The Impact of a Sharp Oil Price Increase. G. E. Angevine. June 1980. (Price $10.00, 122 pages) ISBN 0-920522-13-0.

Working Papers (are available at a cost of 5¢ per page)

78-1 Drilling and Field Construction Costs in the Canadian Petroleum Industry. Gordon M. Engbloom, Confer Consulting Limited. January 1978 (83 pages). OUT OF PRINT.

78-2 Some Supply Price Estimates for Synthetic Crude Oil in Canada. Z. Charles Slagorsky. April 1978 (42 pages).

78-3 Past and Future Energy Costs in the Canadian Economy. Anthony P. Ellison. April 1978 (136 pages). OUT OF PRINT.

78-4 Canadian Electric Utility Industry Costs, 1960-1990. Gerard J. Protti. May 1978 (218 pages).

78-5 Enhanced Oil Recovery Potential in Canada - A Methodological Preview. J. Philip Prince. June 1978 (184 pages). OUT OF PRINT.

78-6 Regional Energy and Production Data for Canadian Manufacturing Industries: 1962-74. Robert N. McRae and Alan R. Webster. July 1978 (106 pages). OUT OF PRINT.

78-7 Regional Demand for Energy by Canadian Manufacturing Industries. Robert N. McRae. October 1978 (132 pages).

79-1 An Input-Output Analysis of the Effects of Rising Energy Costs on Canadian Industries. Anthony P. Ellison. April 1979 (246 pages). OUT OF PRINT.

79-2 Potential Markets for Thermal Coal in Canada, 1978-2000. Canadian Resourcecon Limited. June 1979 (321 pages).

79-3 Inter-City Comparisons of Canadian Household Energy Costs. Darcy-Gail Ackerman. June 1979 (77 pages). OUT OF PRINT.

80-1 Government Incentives in Canada's Petroleum Industry. W. B. Friedenberg, Z. C. Slagorsky, and A. J. Walsh. March 1980 (43 pages).

80-2 A Regionalized Electricity Model: Preliminary Analyses. Kenneth D. Foat and Gerard J. Protti. April 1980 (61 pages).

80-3 Alternative Future Supplies of Oil in Canada and Their Costs. Z. Charles Slagorsky. May 1980 (36 pages).

80-4 Prospects for Reduced Oil Consumption in Canada. W. B. Friedenberg and A. J. Nixon. May 1980 (34 pages).

Conferences

Markets for Canadian Uranium. Proceedings of a Seminar Held on October 25, 1979, Calgary, Alberta. (Price $10.00, 89 pages)
ISBN 0-920522-08-4

Number/
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INTRODUCTION

Established March 24, 1975, the Canadian Energy Research Institute (CERI) is a co-operative research organization sponsored by four parties. These are: the Alberta Department of Energy and Natural Resources; Energy Mines and Resources Canada; the University of Calgary; and the Private Energy Research Association--which is composed of corporate and individual members from oil, gas, coal, electrical, nuclear energy and pipeline companies.

As set out in the Agreement among its sponsoring parties, the objective of the Institute is ". . . to develop an economic research capability which is recognized and respected in all matters related to energy, be it generated from petroleum and natural gas, coal, nuclear reactors, hydroelectric generators or any other source." To this end, the Institute undertakes and commissions studies and research analyses in the field of energy economics and energy policy to assist industry and government in dealing with energy problems.

The Institute was formerly housed in space made available to it on campus by the University of Calgary. The close involvement with the University was most helpful in successfully launching the Institute. As more space became necessary, the Institute moved to the Energy Resources Research Building which is located near the University. Other occupants of the building are the Petroleum Recovery Institute, the Computer Modelling Group, and the Alberta Research Council. The building also houses the I. N. McKinnon Memorial Library which contains energy-related books, journals and documents for the use of the research groups mentioned and other interested parties. The interaction with the various groups is extremely helpful for related Institute research projects.

The information presented on the following pages indicates how CERI is funded and administered. There is a brief summary highlighting activities of Institute economists during fiscal year 1980-81 and a report on the status of research projects initiated and/or completed during that period (April 1, 1980 to March 31, 1981). A complete list of CERI publications is included.

INSTITUTE FUNDING AND FINANCE

The second five-year Institute Agreement, covering the period to March 31, 1985, provides for annual grants to the Institute as indicated below. The annual contributions of the Alberta Government and of the Private Energy Research Association have been doubled from former levels of $125,000 and $100,000 respectively. Payments by the Government of Canada continue at $125,000 per year as in the original Agreement.

Alberta Department of Energy and Natural Resources.....$250,000

Energy Mines and Resources Canada.....$125,000

Private Energy Research Association.....$200,000

The University of Calgary provides the Institute with access to its research facilities on the same basis as that afforded a department of the University. It also serves as trustee of Institute funds and acts as accountant for Institute financial receipts and disbursements.

During the fiscal year ended March 31, 1981, the above-noted contributions from the three funding organizations were deposited in the University of Calgary Trust Account. Total expenditures during 1980-81 amounted to $524,588 in comparison with $525,077 in 1979-80; $366,930 in 1978-79, $295,574 in 1977-78; and $44,629 in the two-year period 1975-77.

In order to provide for a strong, continuing, research program in the face of rising costs, Canadian corporations which do not support the Institute through the Private Energy Research Association are being asked to become sustaining members. The Global Energy Group of the Royal Bank of Canada supported the Institute in this way in 1980-81. A campaign to attract additional members has been launched.

ADMINISTRATION AND STAFF

The Institute is directed by a Board of Directors through an Executive Director, Dr. G. E. Angevine, supported by a Vice President, Client Services (Dr. J. A. MacMillan), eight economists, two economic analysts, and four other full-time staff. It meets quarterly. Each of the four sponsoring parties names three members to serve on the Board for three-year terms.

The first Executive Director of the Institute, Dr. John A. Dawson, retired at the end of October 1980. At that time the Board of Directors expressed their appreciation for the exceptionally fine job he had done in the initial building of the Institute and for his dedication and leadership in helping to create a creditable Canadian energy economic research organization.

During the fiscal year ended March 31, 1981, members of the Board of Directors, other than the Executive Director, were as follows:

University of Calgary:

F. A. Campbell, Professor, Department of Geology and Geophysics, University of Calgary, Vice-Chairman.

D. J. Cote, Senior Vice-President, UMA Group Ltd., Calgary.

M. M. Williams, President, Calgary Power Ltd., Calgary.

Government of Alberta:

W. D. Dickie, formerly Alberta Minister of Mines and Minerals, Calgary.

M. F. Kanik, Assistant Deputy Minister, Policy Analysis and Planning, Alberta Department of Energy and Natural Resources, Edmonton.

M. G. Pahl, Alberta M.L.A. for Edmonton Mill Woods. (Appointed December 1980 to replace T. L. Sindlinger.)

Government of Canada:

A. R. Hollbach, Assistant Deputy Minister, Economic and Policy Analysis, Energy Mines and Resources Canada, Ottawa. (Appointed May 1980 to replace A. D. Hunt.)

R. W. Morrison, Senior Advisor, Uranium and Nuclear Energy, Energy Mines and Resources Canada, Ottawa. (Appointed May 1980 to replace O. J. C. Runnalls who had resigned in June 1979.)

G. Taylor, Director, Energy and Resource Policy, Department of Finance, Ottawa. (Appointed in August 1980 to replace A. S. Rubinoff.)

Private Energy Research Association:

Z. Kolisnyk, Vice President, Development, Fording Coal Limited, Calgary. (Appointed November 1980 to replace R. W. MacPhail of Kaiser Resources Ltd.)

A. H. Ross, President, Allaro Resources Limited, Calgary, Chairman.

D. G. Stoneman, Senior Vice-President, Development, Shell Canada Resources, Calgary. (Appointed February 1981 to replace E. M. Lakusta of Gulf Canada Resources Inc.)

INSTITUTE ACTIVITIES - HIGHLIGHTS

It is a policy of the Institute that its professional staff contribute to economic thought throughout Canada. Thus, in addition to the publication of studies and working papers, Institute economists participated in many other activities during the 1980-81 fiscal year. Some such endeavours are indicated below.

The former Executive Director of the Institute, Dr. J. A. Dawson, spoke on "The Results of Failure to Become Energy Self-Sufficient" at the National Conference of the Society of Management Accountants in Calgary in July 1980.

- In early September, he presented a paper on "Fiscal Incentives and Government Regulation in Canada's Petroleum Industry" at a conference of western energy-rich countries held in Oaxaca, Mexico.

- Later in September, Dr. Dawson spoke on "Energy Supply/Demand in Canada in the 1980s" at a conference in Edmonton hosted by WESTAC, the Western Transportation Advisory Council.

- In November 1980, he and Dr. Philip Prince, former staff economist, appeared before The Special Committee of the Senate on the Northern Pipeline respecting Enhanced Oil Recovery in Canada.

The new Executive Director, Dr. G. E. (Gerry) Angevine, participated in meetings of the MacLean's Board of Economists held in Toronto in May and December.

- In January 1981, Dr. Angevine spoke to a Calgary petroleum resource evaluation seminar sponsored by the Canadian Society of Petroleum Geologists on "Petroleum Resource Estimates and Economic Analysis."

- Later, in March, the Executive Director presented a paper on "Canadian Energy Developments Through the 1980s" at the All-Sector Housing Conference held in Ottawa. He drew upon work being done by Barbara Green, staff economist, with regard to regional trends in heating costs.

• Dr. Angevine visited several of the Atlantic Provinces in December 1980 to interest government energy officials and economists in the work of the Institute. He also met with representatives of the New Brunswick Electric Power Commission, the Newfoundland Petroleum Directorate, the Council of Maritime Premiers, the Nova Scotia Power Corporation, and the Atlantic Provinces Economic Council.

Dr. J. A. (Jim) MacMillan joined the Institute in January 1981 as Vice President, Client Services. His main role will be to help to secure research contracts and additional Institute funding from governments, industry associations, utilities, and corporations. Dr. MacMillan joined the Executive Director in meetings with government energy officials in Manitoba and Saskatchewan.

In October, Dr. Dawson and Dr. Angevine chaired panel sessions at a conference sponsored by the University of Calgary's Department of Economics which had as its theme "Energy--Coping in the Nineteen Eighties." Charles Slagorsky, senior staff economist, spoke at the conference on "The Costs and Benefits of Canadian Oil Self-Sufficiency."

• In December, Charles Slagorsky gave a talk to a luncheon meeting of the Canadian Institute of Energy on "The Costs of Alternative Liquid Fuels." Later, in February, he spoke at the annual conference of the Toronto Association of Business Economists Inc. on "The Economics of Oil Self-Sufficiency in Canada." He also gave a presentation on "Alternative Liquid Fuels" to the University of Calgary's Department of Geology and Geophysics.

• In August, G. J. (Gerry) Protti, senior economist and research advisor, presented the results of Study No. 10 to senior officers of the Newfoundland and Labrador Hydro Corporation. Discussions held at the same time regarding contract research subsequently led to the initiation of work by CERI for that corporation. During the following month, Mr. Protti participated as a panelist at the World Energy Conference held in Munich. A paper written jointly by he and W. B. Friedenberg (former staff economist) was prepared for the conference.

In January 1981, Gerry Protti and Ken Foat, staff economist, attended a conference of users of the Baughman/Joskow Regionalized Electricity Model sponsored by the Electric Power Research Institute in Palo Alto, California. They also discussed issues relating to energy

supply modelling with members of the Energy Modeling Forum in Stanford, California.

CERI economists kept in close contact with professionals involved in research work in the field of energy economics. A number of meetings were held for this purpose, both in Calgary and elsewhere.

In November, the Executive Director and CERI economists attended the annual meeting of the Private Energy Research Association (PERA). On that occasion the economists spoke briefly, providing outlines of their research projects to PERA members, and Dr. Angevine reviewed developments at the Institute.

By way of summary, 1980-81 was an active year in the growth of the Canadian Energy Research Institute. The wide range of research projects completed and underway brought Institute staff into increased contact with both industry and government representatives. In addition, the role of the Institute was given new impetus by the decision of the Board to have CERI actively seek and carry out contractual research. This will help to broaden the financial base of the Institute and to make the expertise of Institute energy economists accessible to a wide range of potential clients.

Board of Directors' Annual Report April 1, 1980 to March 31, 1981

CANADIAN
ENERGY
RESEARCH
INSTITUTE

RESEARCH

A. INSTITUTE - FUNDED RESEARCH

The year 1980-81 was an active one for the Institute. Three new studies and three working papers were published. Nine new Institute-funded research projects were launched. A brief description of each of the studies released during 1980-81 is provided below.

No. 10 The Impact of Rate Structure Change on Electricity Demand: A Case Study of Calgary Power Limited. Gerard J. Protti (staff economist) and Robert N. McRae (consultant), April 1980, 182 pages.

"The increased real costs of most factors of production, combined with the rising prices of their substitutes and complements, have placed increasing pressures on utilities and provincial governments to more closely examine pricing issues." In particular, ". . . marginal cost pricing has been offered as a panacea to solve the various problems that arise in the electric utility industry." These factors, and a general lack of information regarding the potential impact of changes in electricity rates on consumption patterns, led the authors to develop a computer model to facilitate estimation of the effects of rate structure changes on customer consumption levels and patterns and on a given utility's total energy sales and system load shape.

To test the methodology, they used their model to analyse the impact on Calgary Power Limited's future sales and on its future peak load if the utility were to convert its present average-cost-based rate structure to a marginal-cost-based pricing structure. Calgary Power officials were particularly helpful in providing data. However, the analysis and the interpretation of the results are the responsibility of the authors.

Five rate design scenarios, which vary according to how peak and off-peak hours were defined and how the marginal costs were apportioned over time, were developed in order to provide a representative range of potential rate designs. The scenarios ranged from one with a high degree of time-differentiation in the rate structure, with eight

separate pricing periods in a calendar year, to one wherein the rates were not time-differentiated.

Each rate structure alternative was examined to determine its impact on individual customer classes (nineteen, in the Calgary Power study), and in aggregate on Calgary Power's future total system peak load and energy sales. The cost implications of these changes for the utility were then examined.

The authors concluded that the use of an electricity rate structure based on marginal costs without time-of-day or seasonal variations is capable of producing lower future peak loads and total energy sales than Calgary Power Limited's existing average-cost-based rate structure. In turn, such pricing could lead to lower future electric power generating, transmitting, and distributing costs than either Calgary Power's present pricing structure or marginal cost pricing schemes embodying time-of-day or seasonal variation in the rate structure. While this finding may not hold for other Canadian utilities, it does appear that time-differentiated marginal cost pricing cannot be regarded as offering the best pricing option in every utility's case.

"The results of this case study clearly indicate the powerful potential that rate structure change has, even under very conservative assumptions as to the price responsiveness of customers, for influencing electricity system peak loads and energy sales."

No. 11 The Impact of a Sharp Oil Price Increase. G. E. Angevine, June 1980, 122 pages.

The effects on the Canadian economy of a sharp increase in both domestic and world oil prices would be substantial. The generally higher energy prices that would result from higher oil prices would increase unit production costs and selling prices over a wide range of commodities, adding to inflation and slowing the pace of economic growth. Also, the incentives for increased oil production provided by higher domestic oil prices and the increased value of exported natural gas could lead to a substantial improvement in Canada's international balance of payments. Effects on the overall structure of the economy would be modest, but changes in industrial output levels and the impact upon individuals, firms and regions which are heavy net consumers of oil and natural gas would be significant.

These are some of the conclusions reached by the author of this study in which he examined the likely effects of higher oil prices on the macroeconomic growth and inflation aggregates, Canada's balance of international payments, industry prices, the composition of industrial output and government finances.

The potential effects on the Canadian economy of a sharp oil price increase were examined through comparison of two cases, one with relatively modest increases in world prices of oil and Canadian prices rising to world levels over a six-year period ending in 1985, and the other with world prices of oil rising more rapidly and Canadian oil prices rising to meet the cost of imported oil within two years. No corrective fiscal or other policy measures that could be taken to alleviate economic problems arising from rapid energy price escalation were introduced in the second, or sharp oil price increase, scenario.

The two scenarios that were compared in order to consider these various impacts differed not only with respect to the oil price assumptions, but also in that other energy prices were assumed to increase more rapidly in the sharp oil price increase case. In addition, both a downward adjustment in consumer oil and natural gas spending in response to higher real oil and gas prices and a producer response, in terms of increased investment and production in the energy sector, were explicitly assumed. The indirect effects on the Canadian economy via the impact of more rapidly increasing world oil prices on economic growth and inflation in the major countries with which we trade were also taken into account.

The effects of the assumed sharp oil price increase on aggregate production levels, inflation and employment would not be insignificant. The overall rate of inflation would average about 2.5 percentage points higher during the first five years. Generally higher prices would reduce the aggregate demand for goods and services, slowing the rate of growth of the economy by an annual average factor of 0.6 percent during the 1980-84 period, and raising the unemployment rate by about 1.3 percentage points during the same time. Over the latter half of the decade, however, the general rate of price increase would be slower than if the movement of domestic oil prices to parity with the world oil price level were delayed and the rate of growth of the economy would, correspondingly, be somewhat more rapid.

In general, the analysis suggests that prices of products of energy-intensive processes could be expected to rise the most rapidly if there were a sharp oil price increase but that the impact on the economy-wide price structure would be significant and pervasive.

Manufacturing sectors producing machinery, electrical equipment and other construction-related products would also experience a marked rise in selling prices if, as assumed in this study, a strong capital investment response were to accompany an acceleration in the rates of increase in both world and domestic oil prices.

No. 12 Benefits and Costs of Oil Self-Sufficiency in Canada. J. A. Dawson and Z. C. Slagorsky, February 1981, 97 pages.

In this study, virtually completed prior to the unveiling of the National Energy Program, the authors point out that high risks are associated with continued dependence on foreign sources of oil supply. Furthermore, the costs of imported oil are likely to continue to be higher than the costs of oil that could be developed from Canadian sources.

Alternative forecasts of oil consumption and production (1980-2000) are reviewed. Impacts of higher oil prices, gas pipeline extension and government conservation measures are included in the study, and potential production from five sources (conventional oil, frontier oil, oil sands, heavy oil and enhanced recovery) are analyzed. Liquid fuel alternatives, the need for improved cost information, and government incentives are discussed in separate chapters. ". . . even if we move vigorously on measures to conserve energy and on the substitution of various other forms of energy for oil, it is unlikely that we can achieve more than a holding of the line on the annual consumption of oil in Canada over the coming decade. In the light of these prospects it is evident that Canada must either increase oil imports or increase expenditures in Canada on non-conventional, frontier and offshore sources of oil."

"The issue of energy self-sufficiency for Canada comes down to how much of our prospective oil requirements are to be met from Canadian sources," the authors say. Canada currently has an exportable surplus of natural gas and electricity. "For oil, however, the situation is different. While we reached the point where we were exporting an amount of oil equivalent to our imports in the early 1970s, crude oil producibility in Canada has since been declining. For conventional sources in the western sedimentary basin, production is about 20 percent below the peak that was reached and the decline will continue in the years ahead."

The authors indicate that price increases could lessen the rate of growth of oil consumption in Canada to an estimated 1.0 percent per annum between now and the year 2000. This reduction in the rate of increase in oil consumption, coupled with extension of the natural gas pipeline system to enable additional substitution of gas for oil in Quebec, the Maritime provinces and Vancouver Island, could further reduce the rate of increase in oil consumption to 0.6 percent per annum. With these two features, imports could be held to 500 thousand barrels per day by 1985 and eliminated by 1990."

"Even with the full set of measures, however, including higher rates of price increase, extension of the natural gas pipeline system, and the conservation measures, Canada would continue to have to import oil in the mid-1980s at a rate of at least 300 thousand barrels per day."

The study also indicates that development of alternative liquid fuels including methanol, ethanol and liquefied coal ". . . require increased oil prices to stimulate their development and, in addition, the solution of a number of production and marketing problems."

Conventional oil appears to be the cheapest to supply, while oil from the oil sands is the most expensive. Oil from enhanced recovery of light and medium oil appears comparable to upgraded heavy oil. Oil from both sources is more expensive than that obtained using primary and secondary recovery techniques, but cheaper than frontier oil and oil from the oil sands. Therefore, ". . . given the average supply price estimates, conventional oil followed by oil obtained from enhanced recovery schemes and upgraded heavy oil should be the first sources to be tapped before oil from the oil sands and the frontier regions are brought on stream."

The working papers released during the period April 1, 1980 to March 31, 1981 were:

80-2 A Regionalized Electricity Model: Preliminary Analyses. Kenneth D. Foat and Gerard J. Protti. April 1980, 61 pages.

80-3 Alternative Future Supplies of Oil in Canada and Their Costs. Z. Charles Slagorsky. May 1980, 36 pages.

80-4 Prospects for Reduced Oil Consumption in Canada. W. B. Friedenberg and A. J. Nixon. May 1980. 34 pages.

Some of the information presented in working papers 80-3 and 80-4 is also published in Study No. 12. Working paper 80-2 contains a discussion of Institute experiments with the Baughman/Joskow Regionalized Electricity Model developed in the United States. This engineering-economic model which the authors have been adapting to the Canadian scene is particularly well-suited for regional electricity generating capacity planning purposes.

B. CONTRACT RESEARCH

The Institute is actively seeking financial support in addition to that being provided by its founding sponsors. One way in which this is being achieved is through undertaking specific fee-based research assignments dealing with energy-related matters. The Institute's staff of professional economists have developed considerable expertise with respect to economic analysis pertaining to Canada's energy resources. They are well-equipped to assist government, industry associations and private companies in investigating matters involving energy economics.

The list of parties for whom the Institute has completed, or is undertaking, contract research includes the following:

Alberta Research Council
Alsands Energy Ltd.
Canadian Electrical Association
Newfoundland and Labrador Hydro
Seaconsult Marine Ltd.

The major piece of contract research undertaken during 1980-81 was an energy model survey done for the Canadian Electrical Association (CEA):

Models for Energy Policy Analysis: A Survey. Kenneth D. Foat and Gerard J. Protti.

This report has been released by the CEA to member utilities. It will also be circulated by CERI. The work involved a survey of computerized models which could be used by Canadian electrical utilities to evaluate the implications of changing energy markets and government energy policies. The ultimate objective of the Canadian Electrical Association is to obtain an energy model system capable of meshing the analysis of energy supply activities with that of the demand for energy.

The survey and accompanying analysis delineate the strengths and weaknesses of alternative energy models through the examination of the published literature and available documentation. A large number of models were classified, compared and analyzed against specified evaluation criteria. The authors recommend no single model but, rather, various models which individually delineate energy demand, energy supply and the macro-economy and which could be integrated into a powerful analytical framework. The study concludes with a discussion of issues and recommendations related to the CEA objective of having a versatile energy model system for access by member utilities.

C. RESEARCH PROJECTS UNDERWAY AT THE END OF FISCAL YEAR 1980 - 81

At the end of the Institute's fiscal year, March 31, 1981, an active research program consisting of twelve research projects was underway at the Institute. The projects are listed below under generalized headings.

Impact on the Economy

- Canadian Household Energy Costs: Options for the Future. A study by Barbara Green.
- Regional Investment Patterns: The Influence of Energy Developments. A study by Gordon Douglas.
- Financing Canadian Energy Resource Development. A study by John Dawson, former Executive Director.
- The Net Benefits to Canada of the Uranium Mining and Refining Industry. A study being done for the Institute by Marvin Shaffer and Associates, Vancouver.
- The Economic Impact of Alternative Oil Developments. A study being done for the Institute by Foster Research, Calgary

Electricity

- Canadian Electricity Exports: Costs and Benefits (for the Canadian Electrical Association).
- A Survey of North American Regulatory Procedures with Regard to Utility Research and Development Expenditures (for the Alberta Research Council).
- An Assessment of Costing, Pricing and Load Forecasting Procedures (for Newfoundland and Labrador Hydro).

Coal, Nuclear, and Alternative Fuel Supply Issues

- Alternative Liquid Fuels in Canada's Oil-Deficient Regions. A study by Charles Slagorsky.
- Coal versus Nuclear Power: The Economic and Environmental Tradeoffs--A Regional Analysis. A study being undertaken by Farhood Rahnama.

Petroleum Supply Issues

- Crude Oil Supply and Demand: Major Issues and Alternate Scenarios. A working paper by D. J. Haughey.
- The Potential for Enhanced Oil Recovery in Saskatchewan. An extension of previous Institute work dealing with enhanced recovery prospects. The analysis is being completed by A. Webster.

PUBLICATIONS

Studies

No. 1 The Availability of Capital to Fund the Development of Canadian Energy Supplies. J. R. Downs. November 1977 (Price $3.00, 109 pages) ISBN 0-920522-00-9.

No. 2 The Industrial Demand for Oil and Gas in Ontario. DataMetrics Limited. March 1978 (Price $3.00, 119 pages) ISBN 0-920522-01-7.

No. 3 The Effects of Rising Energy Costs on Canadian Industry. Anthony P. Ellison. April 1979 (Price $3.00, 62 pages) ISBN 0-920522-02-5.

No. 4 Potential Markets for Thermal Coal in Canada, 1978-2000: Summary and Conclusions. Canadian Resourcecon Limited. June 1979 (Price $3.00, 27 pages) ISBN 0-920522-03-3.

No. 5 Energy in Canada: Review and Outlook to 1995. W. Brent Friedenberg. July 1979 (Price $3.00, 140 pages) ISBN 0-920522-04-1.

No. 6 Energy Policy and the Balance of Payments: An Outline of the Issues. T. L. Powrie. July 1979 (Price $3.00, 61 pages) ISBN 0-920522-05-X.

No. 7 Oil and Gas Finding Costs. Russell S. Uhler. September 1979 (Price $3.00, 75 pages) ISBN 0-920522-06-8.

No. 8 Energy Use in Canada in Comparison With Other Countries. Z. Charles Slagorsky. October 1979 (Price $3.00, 91 pages) ISBN 0-920522-07-6.

No. 9 Enhanced Oil Recovery Potential in Canada. J. Philip Prince. March 1980 (Price $10.00, 332 pages) ISBN 0-920522-09-2.

Conclusions and Policy Implications from Enhanced Oil Recovery Potential in Canada, Study No. 9. J. Philip Prince. March 1980 (Price $3.00, 32 pages) ISBN 0-920522-10-6.

No. 10 The Impact of Rate Structure Change on Electricity Demand: A Case Study of Calgary Power Limited. Gerard J. Protti and Robert N. McRae. April 1980 (Price $10.00, 182 pages) ISBN 0-920522-11-4.

Overview and Summary from The Impact of Rate Structure Change on Electricity Demand: A Case Study of Calgary Power Limited. Gerard J. Protti and Robert N. McRae. April 1980 (Price $3.00, 14 pages) ISBN 0-920522-12-2.

No. 11 The Impact of a Sharp Oil Price Increase. G. E. Angevine. June 1980. (Price $10.00, 122 pages) ISBN 0-920522-13-0.

No. 12 Benefits and Costs of Oil Self-Sufficiency in Canada. J. A. Dawson and Z. C. Slagorsky. February 1981. (Price $10.00, 97 pages) ISBN 0-920522-15-7.

Working Papers

78-1 Drilling and Field Construction Costs in the Canadian Petroleum Industry. Gordon M. Engbloom, Confer Consulting Limited. January 1978 (Price $3.00, 83 pages).

78-2 Some Supply Price Estimates for Synthetic Crude Oil in Canada. Z. Charles Slagorsky. April 1978 (Price $3.00, 42 pages).

78-3 Past and Future Energy Costs in the Canadian Economy. Anthony P. Ellison. April 1978 (Price $5.00, 136 pages).

78-4 Canadian Electric Utility Industry Costs, 1960-1990. Gerard J. Protti. May 1978 (Price $10.00, 218 pages).

78-5 Enhanced Oil Recovery Potential in Canada - A Methodological Preview. J. Philip Prince. June 1978 (Price $10.00, 184 pages).

78-6 Regional Energy and Production Data for Canadian Manufacturing Industries: 1962-74. Robert N. McRae and Alan R. Webster. July 1978 (Price $5.00, 106 pages).

78-7 Regional Demand for Energy by Canadian Manufacturing Industries. Robert N. McRae. October 1978 (Price $5.00, 132 pages).

79-1 An Input-Output Analysis of the Effects of Rising Energy Costs on Canadian Industries. Anthony P. Ellison. April 1979 (Price $10.00, 246 pages).

79-2 Potential Markets for Thermal Coal in Canada, 1978-2000. Canadian Resourcecon Limited. June 1979 (Price $15.00, 321 pages).

79-3 Inter-City Comparisons of Canadian Household Energy Costs. Darcy-Gail Ackerman. June 1979 (Price $3.00, 77 pages).

80-1 Government Incentives in Canada's Petroleum Industry. W. B. Friedenberg, Z. C. Slagorsky, and A. J. Walsh. March 1980 (Price $3.00, 43 pages).

80-2 A Regionalized Electricity Model: Preliminary Analyses. Kenneth D. Foat and Gerard J. Protti. April 1980 (Price $3.00, 61 pages).

80-3 Alternative Future Supplies of Oil in Canada and Their Costs. Z. Charles Slagorsky. May 1980 (Price $3.00, 36 pages).

80-4 Prospects for Reduced Oil Consumption in Canada. W. B. Friedenberg and A. J. Nixon. May 1980 (Price $3.00, 34 pages).

Conferences

Markets for Canadian Uranium. Proceedings of a Seminar Held on October 25, 1979, Calgary, Alberta. (Price $10.00, 89 pages) ISBN 0-920522-08-4.

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INTRODUCTION

Established March 24, 1975, the Canadian Energy Research Institute (CERI) is a co-operative research organization sponsored by five parties. These are: the Alberta Department of Energy and Natural Resources; Energy, Mines and Resources Canada; the University of Calgary; the Private Energy Research Association--composed of corporate and individual members from oil, gas, coal, electrical, nuclear energy and pipeline companies--and the Ontario Ministry of Energy.

As set out in the Agreement among its sponsoring parties, the objective of the Institute is "...to develop an economic research capability which is recognized and respected in all matters related to energy, be it generated from petroleum and natural gas, coal, nuclear reactors, hydroelectric generators or any other source." To this end, the Institute undertakes and commissions studies and research analyses in all aspects of energy economics and energy policy to assist industry and government in dealing with energy problems.

The Institute is housed in the Energy Resources Research Building which is located near the University of Calgary. Other occupants of the building are the Petroleum Recovery Institute, the Computer Modelling Group, and the Alberta Research Council. The building also contains the I. N. McKinnon Memorial Library's collection of energy related books, journals and documents. Interaction with the various groups is extremely helpful for related Institute research projects.

CERI FUNDING

The second five-year Institute Agreement, covering the period ending March 31, 1985, provided for annual grants to the Institute as follows:

Alberta Department of Energy and Natural Resources...$250,000

Energy Mines and Resources Canada.....$125,000

Private Energy Research Association.....$200,000

Beginning in fiscal 1982-83, the Ontario Government has agreed to contribute $75,000 per year to the Institute through the remainder of the period covered by the current Agreement.

The University of Calgary provides the Institute with access to its research facilities on the same basis as that afforded a department of the University. It also serves as trustee of Institute funds and acts as accountant for Institute financial receipts and disbursements.

Contributions from the funding organizations are deposited in a trust account with the University of Calgary. Total expenditures during 1981-82 amounted to $832,809 in comparison with $530,476 in 1980-81; $525,077 in 1979-80; $366,930 in 1978-79; $295,574 in 1977-78; and $44,629 in the two-year period 1975-77.

In order to provide for a strong, continuing, research program in the face of rising costs, Canadian corporations which do not already support the Institute through the Private Energy Research Association are being solicited to join the Association. A campaign to attract additional members has been launched with the assistance of Mr. William Farmilo, Chairman, Westmin Resources Ltd., Calgary.

CERI ADMINISTRATION AND STAFF

The Institute is directed by a Board of Directors through an Executive Director, Dr. G. E. Angevine, supported by a Vice-President, Client Services, Dr. J. A. MacMillan, ten economists, two economic analysts, and five other full-time staff members. The Board meets quarterly. The sponsoring parties name members to serve on the Board for three-year terms.

During the fiscal year ended March 31, 1982, members of the Board of Directors, other than the Executive Director, were as follows:

University of Calgary:

F. A. Campbell, Professor, Department of Geology and Geophysics, University of Calgary, Vice-Chairman.

D. J. Cote, Senior Vice-President, UMA Group Ltd., Calgary

M. M. Williams, President, TransAlta Utilities Corporation

Government of Alberta:

W. D. Dickie, formerly Alberta Minister of Mines and Minerals, Calgary.

M. F. Kanik, Associate Deputy Minister, Finance and Administration, Alberta Department of Energy and Natural Resources, Edmonton.

M. G. Pahl, Alberta M.L.A. for Edmonton Mill Woods.

Government of Canada:

L. M. Good, General Director, Energy Policy Analysis Sub-Sector, Energy, Mines and Resources Canada, Ottawa. (Appointed November 1981 to replace A. R. Hollbach.)

R. W. Morrison, Senior Advisor, Uranium and Nuclear Energy; Energy, Mines and Resources Canada, Ottawa.

I. E. Bennett, Director, Energy and Resource Policy, Department of Finance, Ottawa. (Appointed March 1982 to replace G. Taylor.)

Private Energy Research Association:

Z. Kolisnyk, Vice-President, Development, Fording Coal Limited, Calgary.

A. H. Ross, President, Allaro Resources Limited, Calgary, Chairman.

D. G. Stoneman, Senior Vice-President, Development, Shell Canada Resources, Calgary.

W. W. Stevenson, Executive Co-ordinator of the Strategic Planning and Analysis Group of the Ontario Ministry of Energy, has been appointed to the board by Ontario which became a sponsor of CERI on April 1, 1982. B. S. Norford of the Institute for Sedimentary and Petroleum Geology has replaced D. J. Cote whose term on the Board expired March 31, 1982.

CERI ACTIVITIES - HIGHLIGHTS

It is a policy of the Institute that its professional staff contribute to economic thought throughout Canada. Thus, in addition to the publication of studies and working papers, Institute economists participated in many other activities during the 1981-82 fiscal year. Some such endeavours are indicated below.

The Executive Director, Dr. G. E. (Gerry) Angevine and the Vice-President, Client Services, Dr. J. A. (Jim) MacMillan met with officials in a number of provinces. This led to the Institute being awarded two research contracts by the British Columbia Department of Energy, Mines and Petroleum Resources and the Ontario Ministry of Energy agreeing to become an Institute sponsor. Because CERI is a Canadian institute analysing economic aspects of all forms of energy, continued discussions with provinces other than Alberta and Ontario will lead to broadened provincial support and participation in the Institute and its research programs.

In the field of public service a series of seminars were held at CERI during the year with government, industry, and University of Calgary representatives attending. Seminars will continue to be organized in Calgary and hopefully in other centres in order to provide the Institute with the opportunity to contribute to the ongoing discussion of energy economic thought, providing a needed service to academics, government, business, and the general public.

At the first seminar, held in June, 1981, Professor Don Daly of York University spoke about the results of his research into the benefits and costs of nationalizing multinational oil companies. Comments on his remarks were provided by economist A. Bruce of Esso Resources Ltd. and a lively discussion followed.

A second seminar was held in November, 1981, at which Charles Slagorsky, CERI Senior Economist, discussed the preliminary results of his research into alternative liquid transportation fuels. A number of government and industry

spokesmen participated. The proceedings, "Economic Potential of Alternative Transportation Fuels", have been published and are available from the Institute.

At the third seminar, held in March, 1982, Alan Webster, Senior Economist, presented results of his analysis of the impact of changed fiscal parameters on the economics of enhanced oil recovery (EOR). The interest of industry and government representatives was high and they made a number of useful suggestions. As a result of this interaction a number of companies volunteered to provide reservoir-specific data for EOR analysis to assist further research.

There are a number of research institutes situated in Calgary which, like CERI, are affiliated in some way with the University of Calgary. Directors of the various institutes began to meet regularly during 1981-82 in order to discuss matters of common concern such as financing, staffing, and space requirements. The Canadian Energy Research Institute actively supported the new group and hosted one of its meetings.

The Institute has continued to gain acceptance throughout the country. Institute eonomists made over ten presentations during the year. These presentations were to such diverse audiences as the MacLean's Board of Economists, The Toronto Ryerson Institute, the Second World Congress of Chemical Engineering in Montreal, and Canadian Electrical Association economists, to name a few.

By way of summary, 1981-82 was an active year in the growth of the Canadian Energy Research Institute. The wide range of research projects completed and underway brought Institute staff into increased contact with both industry and government representatives. Also, the taking on of an increased volume of contract research helped to make the expertise of Institute energy economists accessible to clients in government energy departments and in industry.

CERI RESEARCH

A. INSTITUTE - FUNDED RESEARCH

CERI's 1981-82 research program resulted in 15 Institute-funded projects in various stages of progress. Study No. 13 and Working Papers 81-1 and 81-2 were published.[1] As the year came to a close, the proceedings of a seminar on the "Economic Potential for Alternative Transportation Fuels" was at the printer and Study No. 14 and Study No. 15 had been completed and prepared for publication. Ten other Institute-funded projects were in various stages of completion. A brief description of the studies and working papers completed during 1981-82 follows:

Study No. 13 Financing Canadian Energy Resource Development. J. A. Dawson, December 1981.

Canadian energy financing is being challenged by changing energy policies and the uncertainties of interest rate fluctuations. Some projects will have to be delayed or abandoned. This conclusion comes from Dr. J. A. Dawson's study which indicates that: (1) Most economic projections for the 1980's indicate an average rate of growth in the Canadian economy of 3.5 percent or less; (2) The total of energy investments projected would amount to $100 billion in 1971 dollars over the period 1981-90. (In current dollars, as spent, the total would be almost $400 billion); (3) The list of mega projects may total $150 billion in current dollars; (4) If rates of price increases and interest rates

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[1]CERI publishes studies, working papers and client research reports. Working papers are usually based on results obtained in the preliminary stages of a research program. Alternatively, they may be reports on research projects of limited scope. Some working papers have eventually been embodied, in condensed form, as part of broader, more comprehensive CERI studies. Reports prepared for clients are released by CERI for general circulation only when both the Institute and the client agree to publication.

remain high and difficult to forecast, some projects with long construction periods are likely to be delayed or abandoned; and that (5) The effect of increased interest rates is even more significant for separately financed mega projects where a project must stand on its own in terms of financial feasibility.

Dr. Dawson suggests that significant changes in sources of energy financing will occur if uncertainties concerning future interest rates continue. In particular, the current aversion to bond issues with long terms and fixed interest rates will persist, with expanding use of preferred shares and debentures that are convertible into common shares and long-term variable loan rates. He also notes that government policy will impinge upon energy resource development investment decisions and points out that: (1) the National Energy Program has made it very difficult to attract foreign equity funds and difficult for foreign-owned firms operating in Canada to raise funds and that (2) the numerous takeovers (public and private) occurring in the Canadianization of foreign-owned activities will have a significant negative impact on Canada's balance of international payments.

Study No. 14 Impacts of Canada's Uranium Mining Industry. Marvin Shaffer and Associates.

In this study the authors examine the economic and environmental impacts of Canada's uranium mining industry. After a careful assessment of the potential for future production from open pit operations in Saskatchewan and from underground mining-type operations in Ontario they conclude that Canada will likely be able to maintain its share of world market requirements to the year 2000. Comparison of the economic impact of uranium mine development and operation in Ontario and Saskatchewan suggests that the indirect or second-round economic effects of both tend to be greater in Ontario, which has the manufacturing base to produce needed machinery and other materials, than in Saskatchewan. Uranium mining in Ontario tends to be more labour-intensive because it is concentrated in underground mining type operations. In addition to the Saskatchewan/Ontario comparisons, and related multiplier analysis, the authors also compare the economic impact of uranium mining to other types of mining.

A review and assessment of the environmental impacts of uranium mining suggests that the dangers associated with radioactivity are really very small in relation to industrial accident hazards and normal levels of background radiation. Statistically, it is difficult to demonstrate that uranium mine workers are engaged in a more risky occupation than coal miners or those in many other occupations. It does, however, appear that those who work in a uranium mine and also live near the mine site have a greater risk of radiation-related health deterioration than those in many other occupations.

Study No. 15 Coal and Nuclear Electricity Fuels: A Regional Analysis. Farhood Rahnama.

In this study, comparative economic analysis is used to evaluate the relative economics of nuclear and coal-fuelled electric power stations in most regions of Canada. The data used were provided by the electric utilities themselves.

A simplified cash flow method was used, with present value calculations, to yield single levelized total unit energy costs over the lifetime of the generating stations considered. This method required data on capital costs, fuel costs, operating and maintenance costs and lifetime energy output to allow calculation of a single supply price (cost) for each alternative in each region in terms of mills per kilowatt hour. Sensitivity analysis was used to illustrate the effects of significant changes in some of the cost data on the levelized total unit energy costs.

The author notes that fuel cost accounts for the greater portion of the overall differential between total generating costs of nuclear and coal-fuelled power stations. Coal-fuelled stations are very sensitive to the final price of coal. For this reason it is advantageous to locate coal-fired power stations so as to minimize coal transportation costs over the life of the plant.

The analysis indicates that in Quebec, Ontario, Manitoba and British Columbia nuclear energy is less costly than coal for electric power generation, given the data and assumptions used. In Alberta, coal was found to have a comparative advantage over nuclear energy for electricity generation. In the Maritimes, coal had a marginal advantage over

nuclear power. However the capital cost of the Point Lepreau station in New Brunswick was used for the Atlantic region cost comparisons. It is likely that the cost of additional units at Lepreau will be significantly lower in real terms such that in the Atlantic Region, too, nuclear power may be the more advantageous of the two alternatives.

Working Paper 81-1 Crude Oil Supply and Demand: Major Issues and Alternative Scenarios. Douglas J. Haughey. July 1981.

In this working paper the author indicates that significant capital investment is required in the refining industry resulting from changing crude oil supply and demand factors. A discussion of crude oil supply focuses on the following features of Canadian oil distribution: (1) regional crude oil surpluses and deficits; (2) regional crude oil usage by source of supply (western Canada, U.S. crude oil exchange agreement, and offshore crude); (3) domestic crude oil pipeline streams (Alberta, Saskatchewan and Manitoba) and major crude oil transmission lines; and (4) the quality of foreign crude imports by country of origin. In addition, various crude oil supply scenarios are reviewed including: established reserves, extensions and discoveries, tertiary, pentanes plus, oil sands, upgraded heavy and frontier.

Mr. Haughey points out that the availability of crude oil among Canadian refining regions varies substantially with respect to both product quality and price. Government regulations had resulted in a low effective price for high-quality imported oil. Alberta distribution controls and preferential treatment given to Alberta refineries by the Alberta Petroleum Marketing Commission, combined with increasing foreign supplies of lower quality heavier crude, resulted in the need for modifications in eastern Canadian refineries.

This paper summarizes the first stage of a more detailed analysis underway at the Canadian Energy Research Institute of the impact of changing crude oil supply factors on the Canadian petroleum industry. The next stage will relate more specifically to the 38 crude oil refineries operating in Canada.

Working Paper 81-2 Natural Gas Pricing in Canada: An Economic Analysis. A. J. Nixon, November 1981.

This working paper is an M.A. thesis the author wrote for the University of Calgary. Part of the work was undertaken while she was on the staff of the Institute as an economic analyst.

The theme of the paper is that the pricing of natural gas is a critical ingredient in Canada's energy strategy. Government policies related to natural gas price formation will affect energy supply and demand, the distribution of energy-related economic rents, and the whole question of social welfare and resource exploitation.

A gradual deregulation of domestic natural gas prices is suggested. It would result in an overall net gain to producers and consumers. This net gain would be a function of the magnitude of change in natural gas prices as well as the shape of the producers' supply curve and consumers' demand curve. Even allowing natural gas prices to fall to equilibrium levels will result in a misallocation of resources if crude oil prices were to remain artificially low. Domestic oil prices should rise to world levels, enhancing the attractiveness of natural gas, reducing oil demand, and stimulating oil supply.

Seminar Proceedings: Economic Potential for Alternative Transportation Fuels: Methanol, Ethanol, Propane, Liquified Coal, Compressed Natural Gas and Hydrogen. Proceedings of a seminar held November 17, 1981.

The rising price of oil and transportation fuels derived from oil has spurred interest in alternative liquid fuels. The economics of supply and demand as well as the technology required to produce these fuels has not been well documented. The "Proceedings" document the assessments made in a Canadian Energy Research Institute study nearing completion and by industry representatives.

Seminar highlights noted in the publication are as follows:

- Propane and compressed natural gas are available in Canada at a lower cost than the current comparable cost of gasoline--Charles Slagorsky, Senior Economist, Canadian Energy Research Institute,

- Methanol may have an advantage over other alternative fuels in the long-run since it is relatively inexpensive to produce with existing technology from the large available reserves of Alberta coal and gas--M. D. MacDonald, Economist, Alberta Energy Resouces Conservation Board.

- Canadian crude oil import purchases are being heavily subsidized. If that subsidy were applied to alcohol production it would be fully competitive--A. E. Meyer, P. Eng. R.D.C. Research, Development and Consulting Ltd.,

- Oil can be produced by coal pyrolysis with a levelized price of $35 per barrel (1981 $) over the expected life of the facility--Z. Kolisnyk, Vice-President, Development, Fording Coal Limited,

- Canada is importing crude oil while surplus gas is shut-in. Surplus gas could be used to produce compressed natural gas (CNG) transportation fuel at 55 percent of the cost of gasoline--Richard E. Wyman, Director of Research, Canadian Hunter Exploration Ltd. and Vice-President, CNG fuel Systems Ltd.,

- Hydrogen in the long-term does appear to be an attractive alternative; however, the lack of data on fuel supply costs of other fuels, power system costs and total systems efficiency make it impossible to compare hydrogen to carbon-based fuels on a comprehensive basis--B. Yang, Manager, Transportation and Community Energy Management, Ontario Ministry of Energy,

- Government programs and pricing mechanisms place natural gas and natural-gas-derived fuels in a preferential position relative to gasoline and all other potential fuels--G. Mathieson, Project Co-ordinator, Alberta Gas Ethylene.

B. CONTRACT RESEARCH

One of the original purposes of the Institute, namely to create an institute with a reputation for thorough, objective, energy economic research, is now being achieved. Government, industry associations and corporations have accepted its work and chosen the Institute to perform research in specific areas of interest to them. The Institute's staff of professional economists, having developed considerable experience with regard to economic analysis pertaining to Canada's energy resources, are now recognized. Their ability to assist government, industry associations and private companies in investigating matters involving energy economics is being sought after. This acceptance is highly justifying as it demonstrates that the Institute is fulfilling a needed function in the Canadian scene.

The list of parties for whom the Institute has completed, or is undertaking, contract research includes the following:

Alberta Research Council
Alsands Energy Ltd.
British Columbia Ministry of Energy, Mines and Petroleum Resources
Canadian Electrical Association
Keith Construction Ltd.
Newfoundland and Labrador Hydro
Seaconsult Marine Ltd.

The major piece of contract research undertaken during 1981-82 was an assessment of the benefits and costs of exporting electricity, financed by the Canadian Electrical Association. The study was nearing completion as the fiscal year came to a close. The final report will be published as a CERI client research report.

In January, 1982, CERI economists commenced work on an energy demand model for the Province of British Columbia's Department of Energy, Mines and Petroleum Resources. This is a major project in the energy modelling field. In 1981-82 CERI also undertook assessment of the data and forecast

methodologies used by the British Columbia Government to assess supplies of natural gas liquids. The Institute's report was tabled with the Govier Commission enquiry into natural gas and natural gas liquid supplies.

Work continued on an assessment of load forecasting and rate-determination practices for Newfoundland and Labrador Hydro. It is anticipated that that project will have been completed by July 1982.

A report prepared early in the year for Keith Construction Ltd. of Calgary under contract was later published by CERI. A brief summary follows:

Client Research Report 82-1 The Economics of Improved Energy Efficiency in New Calgary Housing By Barbara E. Green, March 1982.

This report indicates that some 'energy saving' features considered by new home builders are a poor investment for home purchasers. Careful consideration of the economics of 'energy saving' features is required to separate profitable features from the many alternatives being promoted by building industry suppliers. The author indicates how a homeowner or purchaser can calculate the energy requirements for home space heating and how to calculate the profitability of an investment in energy saving alternatives.

Observations made in the study include the following: (1) insulating basements, and improving airtightness is relatively inexpensive and generates the greatest savings; (2) upgrading of ceiling and wall insulation is expensive but not cost-effective; (3) triple-glazed windows are a doubtful investment compared to double-glazed windows; and (4) the profitability of alternative energy saving features is not very sensitive to changing interest rates or rising energy prices.

This report draws on the methodology being used in a more detailed analysis of household energy costs in 11 major Canadian cities underway at CERI. The broader study will analyze alternative energy types, the energy costs of appliances, and home energy conservation alternatives on a regional basis.

In addition to the above-noted client research report, the Institute published a discussion paper entitled Significance of Interregional Feedbacks for Canadian Regional Energy Policy Decisions. Written by G. W. Douglas and J. A. MacMillan, the discussion paper is related to analysis of data originally provided by Alsands Energy Ltd. for a CERI impact analysis of the Alsands project plant and townsite construction.

C. RESEARCH PROJECTS UNDERWAY AT THE END OF FISCAL YEAR 1981-82

At the end of the Institute's fiscal year, March 31, 1982, an active research project consisting of twelve research projects was underway at the Institute. The projects are listed below under generalized headings.

Impact on the Economy

- Canadian Household Energy Costs: Options for the Future. A study by Barbara E. Green and Brian D. Sumner.
- Regional Investment Patterns: The Influence of Energy Developments. A study by Gordon W. Douglas.

Coal

- Development Options for Canadian Coal: A Review. Several working papers will be issued focussing on the regional options. These will then be brought together as a study. Z. Charles Slagorsky and Kristi E. Varangu are actively involved in the project.

Electricity

- Canadian Electricity Exports: Costs and Benefits (for the Canadian Electrical Association). Principal Investigators: Ellen F. Battle, Gordon W. Douglas, and Gordon S. Gislason.
- An Assessment of Costing, Pricing and Load Forecasting Procedures (for Newfoundland and Labrador Hydro) by Gordon S. Gislason.

Alternative Fuel Supplies

- Alternative Liquid Fuels for Canada's Oil-Deficient Regions. A study by Z. Charles Slagorsky.

Petroleum Supply and Demand Issues

- The Potential for Enhanced Oil Recovery. A working paper dealing with the effect of changes in fiscal arrangements on enhanced recovery and a discussion paper dealing with Alberta Government royalties; both by Alan R. Webster.
- Oil Substitution Prospects in Canada, Brian D. Sumner.
- The Impact of Changing Crude Oil Supplies, Douglas J. Haughey.
- Modelling Exploration in Alberta Oil Plays, Kenneth D. Foat and Alan J. MacFadyen.
- The Potential for Reducing Oil Demand Through Conservation, Georgette Habib.

Natural Gas

- Natural Gas Development Options, Douglas J. Haughey and Kristi E. Varangu.

PUBLICATIONS

Studies

No. 1 The Availability of Capital to Fund the Development of Canadian Energy Supplies. J. R. Downs. November 1977 (Price $3.00, 109 pages) ISBN 0-920522-00-9.

No. 2 The Industrial Demand for Oil and Gas in Ontario. DataMetrics Limited. March 1978 (Price $3.00, 119 pages) ISBN 0-920522-01-7.

No. 3 The Effects of Rising Energy Costs on Canadian Industry. Anthony P. Ellison. April 1979 (Price $3.00, 62 pages) ISBN 0-920522-02-5.

No. 4 Potential Markets for Thermal Coal in Canada, 1978-2000: Summary and Conclusions. Canadian Resourcecon Limited. June 1979 (Price $3.00, 27 pages) ISBN 0-920522-03-3.

No. 5 Energy in Canada: Review and Outlook to 1995. W. Brent Friedenberg. July 1979 (Price $10.00, 140 140 pages) ISBN 0-920522-04-1.

No. 6 Energy Policy and the Balance of Payments: An Outline of the Issues. T. L. Powrie. July 1979 (Price $3.00, 61 pages) ISBN 0-920522-05-X.

No. 7 Oil and Gas Finding Costs. Russell S. Uhler. September 1979 (Price $3.00, 75 pages) ISBN 0-920522-06-8.

No. 8 Energy Use in Canada in Comparison With Other Countries. Z. Charles Slagorsky. October 1979 (Price $3.00, 91 pages) ISBN 0-920522-07-6.

No. 9 Enhanced Oil Recovery Potential in Canada. J. Philip Prince. March 1980 (Price $10.00, 332 pages) ISBN 0-920522-09-2.

Conclusions and Policy Implications from Enhanced Oil Recovery Potential in Canada, Study No. 9. J. Philip Prince. March 1980 (Price $3.00, 32 pages) ISBN 0-920522-10-6.

No. 10 The Impact of Rate Structure Change on Electricity Demand: A Case Study of Calgary Power Limited. Gerard J. Protti and Robert N. McRae. April 1980 (Price $10.00, 182 pages) ISBN 0-920522-11-4.

Overview and Summary from The Impact of Rate Structure Change on Electricity Demand: A Case Study of Calgary Power Limited. Gerard J. Protti and Robert N. McRae. April 1980 (Price $3.00, 14 pages) ISBN 0-920522-12-2.

No. 11 The Impact of a Sharp Oil Price Increase. G. E. Angevine. June 1980 (Price $10.00, 122 pages) ISBN 0-920522-13-0.

No. 12 Benefits and Costs of Oil Self-Sufficiency in Canada. J. A. Dawson and Z. C. Slagorsky. February 1981 (Price $10.00, 97 pages) ISBN 0-920522-15-7.

No. 13 Financing Canadian Energy Resource Development. J. A. Dawson. December 1981 (Price $10.00, 68 pages) ISBN 0-920522-17-3.

No. 14 Impacts of Canada's Uranium Mining Industry. Marvin Shaffer and Associates Ltd. May 1982 (Price $10.00, 87 pages) ISBN 0-920522-20-3.

No. 15 Coal and Nuclear Electricity Fuels: A Regional Analysis. Farhood Rahnama. June 1982 (Price $10.00, 81 pages) ISBN 0-920522-21-1.

Client Research Reports

81-1 Models for Energy Policy Analysis: A Survey. Kenneth D. Foat, Gerard J. Protti and Gordon W. Douglas. July 1981 (Price $10.00, 121 pages) ISBN 0-920522-16-5.

82-1 The Economics of Improved Energy Efficiency in New Calgary Housing. Barbara E. Green. March 1982 (Price $10.00, 55 pages) ISBN 0-920522-18-1.

Working Papers

78-1 Drilling and Field Construction Costs in the Canadian Petroleum Industry. Gordon M. Engbloom, Confer Consulting Limited. January 1978 (Price $3.00, 83 pages).

78-2 Some Supply Price Estimates for Synthetic Crude Oil in Canada. Z. Charles Slagorsky. April 1978 (Price $3.00, 42 pages).

78-3 Past and Future Energy Costs in the Canadian Economy. Anthony P. Ellison. April 1978 (Price $5.00, 136 pages).

78-4 Canadian Electric Utility Industry Costs, 1960-1990. Gerard J. Protti. May 1978 (Price $10.00, 218 pages).

78-5 Enhanced Oil Recovery Potential in Canada - A Methodological Preview. J. Philip Prince. June 1978 (Price $10.00, 184 pages).

78-6 Regional Energy and Production Data for Canadian Manufacturing Industries: 1962-74. Robert N. McRae and Alan R. Webster. July 1978 (Price $5.00, 106 pages).

78-7 Regional Demand for Energy by Canadian Manufacturing Industries. Robert N. McRae. October 1978 (Price $5.00, 132 pages).

79-1 An Input-Output Analysis of the Effects of Rising Energy Costs on Canadian Industries. Anthony P. Ellison. April 1979 (Price $10.00, 246 pages).

79-2 Potential Markets for Thermal Coal in Canada, 1978-2000. Canadian Resourcecon Limited. June 1979 (Price $15.00, 321 pages).

79-3 Inter-City Comparisons of Canadian Household Energy Costs. Darcy-Gail Ackerman. June 1979 (Price $3.00, 77 pages).

80-1 Government Incentives in Canada's Petroleum Industry. W. B. Friedenberg, Z. C. Slagorsky, and A. J. Walsh. March 1980 (Price $3.00, 43 pages).

80-2 A Regionalized Electricity Model: Preliminary Analyses. Kenneth D. Foat and Gerard J. Protti. April 1980 (Price $3.00, 61 pages).

80-3 Alternative Future Supplies of Oil in Canada and Their Costs. Z. Charles Slagorsky. May 1980 (Price $3.00, 36 pages).

80-4 Prospects for Reduced Oil Consumption in Canada. W. B. Friedenberg and A. J. Nixon. May 1980 (Price $3.00, 34 pages).

81-1 Crude Oil Supply and Demand: Major Issues and Alternate Scenarios. Douglas J. Haughey. July 1981 (Price $7.00, 158 pages).

81-2 Natural Gas Pricing in Canada: An Economic Analysis. Andrea J. Nixon. October 1981 (Price $5.00, 116 pages).

Discussion Paper

82-1 Significance of Interregional Feedbacks for Canadian and Regional Energy Policy Decisions. Gordon W. Douglas and James A. MacMillan. March 1982 (Price $2.00, 10 pages).

Proceedings

Markets for Canadian Uranium. Proceedings of a Seminar Held on October 25, 1979, Calgary, Alberta. (Price $10.00, 89 pages) ISBN 0-920522-08-4.

Economic Potential for Alternative Transportation Fuels: Methanol, Ethanol, Propane, Liquified Coal, Compressed Natural Gas and Hydrogen. Proceedings of a Seminar Held on November 17, 1981, Calgary, Alberta. ($10.00, 83 pages) ISBN 0-920522-19-X.

Annual Report

Annual Report of the Board of Directors for the Period April 1, 1981 to March 31, 1982. ISBN 0-920522-22-X.